Differences in Potassium Requirement and Response by Older and Modern Cotton Varieties

By J.J. Camberato and M.A. Jones

Late-season potassium (K) deficiencies have occurred in many South Carolina cotton fields over the past few years, with some varieties showing deficiency symptoms more frequently than others. Newer, higher-yielding, fast-fruiting cotton varieties appear to respond more favorably to applied K than older varieties, and may benefit from increased application rates.

In recent years, late-season K deficiencies have been observed in many cotton fields across South Carolina. Some varieties have appeared to show K deficiency symptoms more frequently than others. New, higher-yielding, earlier-maturing cotton varieties develop more of their total boll load over a shorter period of time, which can lead to a more condensed boll filling period and an increased demand for the uptake and mobilization of K from the soil and leaf to the developing lint—from 2 to 4 lb K/A/day.

Since K is the primary osmoticum for fiber development and provides the turgor pressure necessary for fiber elongation, optimum cotton yields and fiber quality are highly dependent upon an adequate supply of K throughout the growing season. Late-season K deficiencies appear to be extremely detrimental to cotton, with reduced fiber quality (especially fiber length, strength, and micronaire) and lint yield, often occurring as a result of late-season K deficiencies.

Excessive drying of the upper soil layers renders K unavailable to the crop, and deep soil layers have little K because downward leaching is limited in relatively high cation exchange capacity soils. Soils in the Coastal Plain region of South Carolina are much different than those in the Mississippi River Delta, and the distribution and availability of K are also quite different. Coastal Plain soils typically have accumulations of K in clayey subsoil layers due to leaching of K incorporated into sandy surface soil layers. The extent of downward K movement during the growing season and access to subsoil K likely governs K availability in Coastal Plain soils. Current K fertilizer recommendations in South Carolina are based on pre-season K levels of the topsoils that are adjusted by depth and K content of the subsoil. The data establishing the subsoil K adjustment to fertilizer recommendations preceded development of these high K-demanding cotton varieties. Research was conducted to determine if current soil sampling procedures and recommendations are valid to optimize yield of modern cotton varieties.

A replicated field experiment was conducted in 2002 and 2003 at the Pee Dee Research and Education Center located in Florence on a Norfolk-Bonneau soil complex (Typic Kandiudult-Arenic Paleudult) identified as K deficient in 2001. The plow layer, upper 8 in. of the E-horizon, and upper 8 in. of the B-horizon were sampled prior to initiating the experiment and analyzed for Mehlich-1 K and soil pH. Depth to the B-horizon was also determined. An attempt was made to optimize yields utilizing a center-pivot irrigation system, a split application of 120 lb N/A,

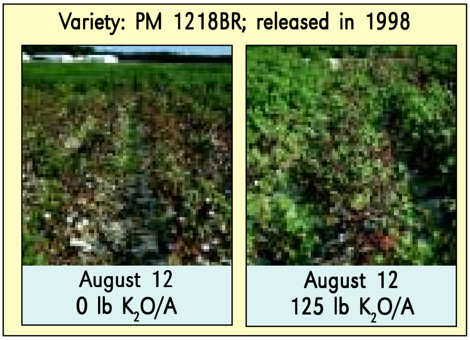

Figure 1. Visual response of cotton variety PM 1218BR to 125 lb K_2O/A.

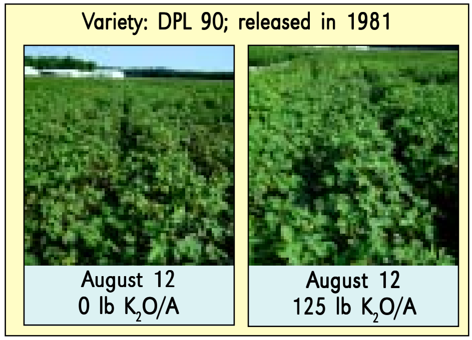

Figure 2. Visual response of DPL 90 to 125 lb K_2O/A.

and intense pest control.

Potassium treatments were broadcast prior to planting at 0, 50, 75, 100, and 125 lb K_2O/A. Five cotton varieties released between the years 1915 and 2001 (Dixie Triumph, 1915; DPL 90, 1981; DES 119, 1985; Paymaster 1218BR, 1998; and DPL 555BR, 2001) were evaluated. The experimental design was a split-plot with K fertilization rate as the whole plot (20 rows wide by 40 ft. long) and variety as the split plot (4 rows wide by 40 ft. long).

Only the center two rows were used for plant tissue and lint harvest. Leaf and petiole samples were obtained every 2 to 3 weeks from first bloom through cutout to monitor K status of the cotton plant. The sap from 20 petioles was squeezed out, and K determined with a Cardy K^+ meter. Leaf tissue was dried, ground, and analyzed for nutrient content by standard laboratory procedures. Weekly white bloom counts from one middle row were conducted. Destructive plant sampling (1 ft. of row) occurred at early squaring (matchhead square) and at cutout, in order to determine changes in dry matter partitioning, boll development, and relative maturity levels. At harvest, plants were mapped to assess changes in fruit distribution throughout the canopy, and plots were machine-harvested. Lint yield, gin turnout, and fiber quality were determined. Response to K fertilization was examined in relation to K fertilization rate and intensity of the boll-filling period (old to new varieties) as it is altered by the supply and distribution of soil K.

Cotton growth and development was significantly altered by the K treatments, and visible differences in deficiency symptoms in the field occurred among varieties and K rates (**Figures 1 and 2**). Significant premature leaf defoliation occurred at lower K application rates, but varied with variety (**Figure 3**). Leaf and petiole K levels were positively related to the sum of the initial soil K level of the A-horizon plus 50% of the K fertilization rate (**Figures 4 and 5**). Including E- or B-horizon K levels and/or a higher or lower percentage of K fertilization rate did not improve these relationships. Leaf K appeared to be a better indicator of K supply than petiole K, but was also more affected by growth stage compared to petiole measurements. Leaf K concentrations were low throughout boll

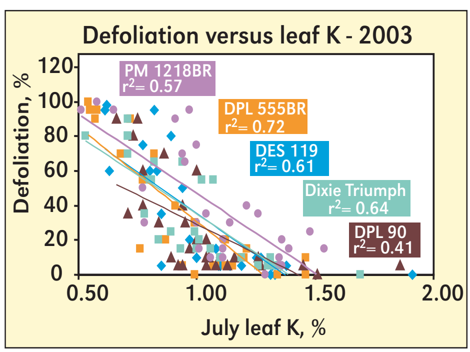

Figure 3. Relationship between premature leaf defoliation and leaf K in July.

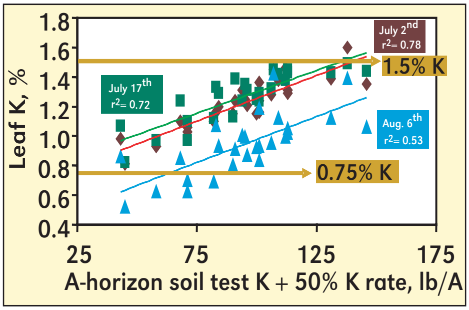

Figure 4. Relationship between percent leaf K and soil test K levels in the A-horizon plus 50% of the applied K rate. Sufficiency range is 1.5 to 3.0% K at early bloom to 0.75 to 2.5% at late bloom.

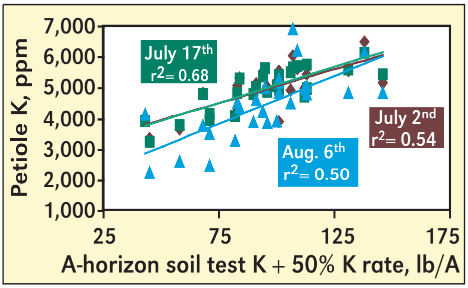

Figure 5. Relationship between petiole K and soil test K levels in the A-horizon plus 50% of the applied K rate.

development (especially with the low K fertilizer treatments), attaining deficiency levels of less than 1.5% at early bloom and less than 0.75% at cutout. All varieties responded favorably to increased levels of leaf K, but the recently released, higher-yielding varieties such as PM 1218BR and DPL 555BR responded more to K than older, lower-yielding varieties such as Dixie Triumph, DES 119, and DPL 90 (**Tables 1 and 2**). Lint yields increased 400 to 800 lb/A with each 1% increase in leaf K. Yields of newly released varieties increased more than older varieties.

Table 1. Variety response to K supply – 2002.

Variety	Leaf %K (8/6) with high K	Change in lint yield per % change in leaf K, lb/%K	Lint yield, lb/A[1]
Dixie Triumph	1.02	409	613
DPL 90	1.26	497	845
DES 119	1.06	666	900
PM 1218BR	1.20	543	962
DPL 555BR	1.25	678	1,056

[1]Average across all K rates.

Table 2. Variety response to K supply – 2003.

Variety	Leaf %K (8/6) with high K	Change in lint yield per % change in leaf K, lb/%K	Lint yield, lb/A[1]
Dixie Triumph	1.18	458	341
DPL 90	1.19	428	594
DES 119	1.21	718	543
PM 1218BR	1.30	528	571
DPL 555BR	1.16	819	643

[1]Average across all K rates.

Based on these recent results, new, higher-yielding, fast-fruiting cotton varieties may respond favorably to higher rates of applied K than older varieties. BC

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